

From Energy Security to Sustainable Development in Nigeria: The Role of Natural Gas

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Abstract

Even though Nigeria is blessed with an abundance of natural gas reserves, the country is still battling a high rate of energy poverty, as much of the population does not have access to clean and affordable energy. Hence, this paper seeks to explore the role of natural gas in enhancing energy security and sustainable development in Nigeria. In doing so, the paper explores specific issues such as the concept of energy security and its relationship with sustainable development, the state of energy security and sustainable development in Nigeria, the potential of natural gas in enhancing energy security and sustainable development in Nigeria, and the challenges and prospects of natural gas development in Nigeria. Relying on data and statistical reports from reliable databases, reports of empirical studies, and an in-depth review of relevant and current literature, the study employs a qualitative research methodology and doctrinal analysis in arriving at its objective. Analyses of data and statistical reports indicate that Nigeria is not making tangible progress towards the realization of energy security due to factors including inadequate energy supply to demand ratio, high cost of energy due to positive energy trade balance, connoting the country's dependence on energy importation to meet its energy demands, and sustainability issues as a result of over-reliance on carbon-intensive energy sources. Further, empirical studies reviewed reveal that this state of energy security has implications for sustainable development in the country. The study, however, finds that the availability of abundant low-carbon energy resources such as natural gas makes its development an imperative for enhancing energy security and sustainable development in Nigeria.

Keywords: Energy security; Sustainable development; Natural gas; Energy trilemma; Nigeria

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من أمن الطاقة إلى التنمية المستدامة في نيجيريا: دور الغاز الطبيعي

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ملخص

على الرغم من أن نيجيريا غنية باحتياطيات الغاز الطبيعي، إلا أن البلاد لا تزال تعاني من معدلات عالية من فقر الطاقة، حيث لا يتمكن الكثير من السكان من الوصول إلى طاقة نظيفة وميسورة التكلفة. ومن هنا، تهدف هذه الورقة إلى استكشاف دور الغاز الطبيعي في تعزيز أمن الطاقة والتنمية المستدامة في نيجيريا. وتتناول الورقة قضايا محددة مثل: مفهوم أمن الطاقة وعلاقته بالتنمية المستدامة، وحالة أمن الطاقة والتنمية المستدامة في نيجيريا، وإمكانات الغاز الطبيعي في تعزيز أمن الطاقة والتنمية المستدامة، والتحديات والفرص المرتبطة بتطوير الغاز الطبيعي في نيجيريا.

تعتمد الدراسة على بيانات وتقارير إحصائية من قواعد بيانات موثوقة، وتقارير دراسات تجريبية، ومراجعة معمقة للأدبيات ذات الصلة والمحدثة، وتستخدم منهجية بحث نوعية وتحليلًا فقهيًا لتحقيق أهدافها. تشير تحليلات البيانات والتقارير الإحصائية إلى أن نيجيريا لا تحرز تقدمًا ملموسًا نحو تحقيق أمن الطاقة، وذلك بسبب عوامل تشمل عدم كفاية نسبة العرض إلى الطلب، وارتفاع تكلفة الطاقة نتيجة لفائض الميزان التجاري للطاقة الذي يدل على اعتماد البلاد على استيراد الطاقة لتلبية احتياجاتها، وقضايا الاستدامة الناتجة عن الاعتماد المفرط على مصادر الطاقة كثيفة الكربون.

كما تكشف الدراسات التجريبية التي تمت مراجعتها أن حالة أمن الطاقة هذه لها آثار على التنمية المستدامة في البلاد. ومع ذلك، تجد الدراسة أن توفر مورد طاقة منخفض الكربون مثل الغاز الطبيعي يجعل تطويره أمرًا ضروريًا لتعزيز أمن الطاقة والتنمية المستدامة في نيجيريا.

الكلمات المفتاحية: أمن الطاقة، التنمية المستدامة، الغاز الطبيعي، معضلة الطاقة، نيجيريا

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Introduction

According to the United Nations, energy consumption constitutes a dominant contributor to climate change, accounting for about 60% of the total greenhouse gas emissions globally.¹ Therefore, energy production and consumption are capable of impeding the realization of the sustainable development agenda. Meanwhile, life and, in fact, the achievement of the sustainable development agenda as a whole, depend to a large extent on the availability of energy.² This connotes energy as a two-edged sword, and as such, it is necessary to create a balance between energy consumption on one hand, and the adverse impacts of energy on the other hand. Furthermore, this highlights the need to exploit energy resources in a manner that ensures that the positive impacts of energy are not outweighed by the negative impacts, and the negative impacts of energy are adequately managed. Arguably, these objectives are summed up in the concept of energy security and sustainable development.

Summarily, therefore, energy security and reduction of the adverse impacts of energy are two overriding challenges the energy sector faces on the path towards sustainable development. Addressing these challenges requires the availability of relatively environmentally friendly energy sources with lower adverse impacts on the environment and climate. Globally, natural gas is increasingly being identified as a viable energy source to address these challenges. Hence, this paper explores the role of natural gas in enhancing energy security and sustainable development in Nigeria.

Subsequent sections of the paper are structured as follows: subsequent aspects of this introductory section present a review of the concept of energy security, the relationship between energy security and sustainable development, and the indicators of energy security in national jurisdictions. While section two presents a conceptual analysis of energy security and sustainable development within the Nigerian context, section three explores the potential of natural gas as a solution to address the dual challenge of energy security and sustainable development in the country. Section four focuses on the challenges and prospects of natural gas development and energy security in Nigeria, and section five concludes the study with the lessons learnt and recommendations.

1. The Concept of Energy Security

Energy security is an evolving terminology that cuts across diverse fields such as economic, political, social, environmental, and technical.³ Currently, there is no singular generally accepted definition of the term, as it is defined severally by different authors and international institutions, using various indices. For instance, Hisham Khatib describes energy security as the continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices.⁴ Similarly, Kowalski and Vilgorac

1 United Nations Sustainable Development Goals “Goal 7: Affordable and Clean Energy”.

2 Ibid.

3 Lazar Gitelman, Elena Magaril, & Mikhail Kozhevnikov “Energy Security: New Threats and Solutions” (2023) *16(6) Energies* 2869.

4 Hisham Khatib “Energy Security” in *World Energy Assessment: Energy and the Challenge of Sustainability* (UNDP, 2000) 112-131.

define energy security as the availability of usable energy supplies at economic price levels and in sufficient quantities and timeliness so that the economic and social development of a country is not materially constrained.⁵ According to the International Energy Agency (IEA), energy security refers to the uninterrupted availability of energy sources at an affordable price.⁶ The Asia Pacific Energy Research Centre defines energy security as “*the ability of an economy to guarantee the availability of the supply of energy resources in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy*”.⁷ According to the World Energy Council, energy security encompasses the reliability of renewables, availability and accessibility of critical energy resources, and resilience of energy resources in the face of physical and other threats.⁸

Notwithstanding the various definitions of energy security that have been given in the literature, it is clear that some central themes cut across all definitions, including availability, accessibility, affordability, and sustainability of energy. Hence, the major elements of the concept of energy security may be summed up into an energy trilemma encompassing issues such as physical energy security, economic energy security, and energy sustainability. While physical energy security entails the availability, reliability, and accessibility of energy supply sources, economic energy security entails the affordability of energy resource acquisition and energy infrastructural development, which ensures that the cost of energy to consumers is minimized. Energy sustainability entails the sustainable development and use of energy resources in a manner that minimizes environmental damage, including decarbonizing energy.⁹

As a result of the rapid economic expansion, industrial growth, and urbanization, as well as emerging new uses of energy globally, energy security is increasingly becoming a pressing issue in many countries around the world. It constitutes a critical issue that is significant to various stakeholders in society, such as policymakers, corporate organizations, and individual members of society, whose quality of life depends on energy services. This is because energy services are paramount to sustain modern lifestyles and business activities. Hence, it is opined that energy is not just a commodity but a precondition for other commodities, and can be likened to other basic factors of survival such as air, water, and earth.¹⁰ The increasing energy security concerns are more so because the supplies of energy resources available to meet the various energy demands are finite and, most of the time, non-renew-

5 George Kowalski & Sead Vilgorac “Energy Security Risks and Risk Mitigation: An Overview”, available at https://unece.org/fileadmin/DAM/oes/nutshell/2008/9_Energy_Security_Risks.pdf [accessed 10 March 2025].

6 International Energy Agency “World Energy Outlook 2022” <https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf> [accessed 10 March 2025].

7 “A Quest for Energy Security in the 21st Century: Resources and Constraints” A Report of Asia Pacific Energy Research Centre (2007) 6.

8 World Energy Council “World Energy Trilemma 2024: Evolving with Resilience and Justice” (2024), available at <https://www.worldenergy.org/publications/entry/world-energy-trilemma-report-2024> [accessed 13 March 2025].

9 Ibid.

10 Benjamin K. Sovacool & Ishani Mukherjee “Conceptualizing and Measuring Energy Security: A Synthesized Approach” (2011) 36(8) Energy 5343-5355.

able.¹¹ Meanwhile, energy insecurity can occasion significant financial, economic, and social risks, which may result in short and long-term socio-economic costs in terms of the loss of production and consumers' welfare, and consumers' adjustments to mitigate their losses.¹² In other words, energy security has implications for the realization of the global sustainable development agenda.

1.1 The Relationship between Energy Security and Sustainable Development

Energy security is an integral and significant aspect of a nation's sustainable development. Empirical studies have shown that energy is correlated with various indices of economic growth and social well-being.¹³ This is because energy is an enabler of economic growth and development due to its role in industries and production processes. Specifically, energy influences productivity in several economic sectors, including industry, health, commerce, education, and agriculture, among others. This is because energy outputs such as light, power, heat, among others, constitute some of the essential inputs that factories and industries run on, and also provide support for education, health, and other social services.¹⁴ This is in addition to its role in domestic activities such as cooking, cooling and heating systems, transportation, among others, which directly affect the quality of life and social well-being.

First, energy is essential to the promotion of health and well-being as required by Goal 3 of the Sustainable Development Agenda. This is because ensuring healthy lives and well-being requires reliable energy. For instance, unreliable access to electricity may make it challenging to operate medical facilities and maintain a functioning cold chain system to keep vaccines refrigerated, thereby causing a public health crisis.¹⁵ Poor energy access also threatens health in the home. Some billions of people, especially those in rural areas, most of the time lack access to clean cooking energy and rely primarily on biomass fuels, which are burnt inefficiently, thereby contributing to environmental degradation and several health risks.¹⁶ In fact, the World Health Organization (WHO) links 3.8 million deaths annually

11 Collins Ayoo "Towards Energy Security for the Twenty-First Century" in Tolga Taner (ed) *Energy Policy* (Intech Open, 2020).

12 Jose Goldemberg "Rural Energy in Developing Countries" in *World Energy Assessment: Energy and the Challenge of Sustainability* (UNDP, 2000) 368-389.

13 See for instance, Warr BS & Ayre RU "Evidence of Causality between the Quantity and Quality of Energy Consumption and Economic Growth" (2010) 35(4) *Energy* 1688-1693; Thai-Ha Le & Canh Phuc Nguyen "Is Energy Security a Driver for Economic Growth? Evidence from a Global Sample" (2019) 129 *Energy Policy* 436-451; Ofosu-Peasah G., Ofosu Antwi & Blyth W. "Factors Characterizing Energy Security in West Africa: An Integrated Review of the Literature" (2021) 148 *Renewable and Sustainable Energy Reviews* 111259.

14 Yacob Mulugetta, Essel Ben Hagan & Daniel Kammen "Energy Access for Sustainable Development" (2019) 14 *Environmental Research Letters* 1.

15 Ofosu-Peasah G., Ofosu Antwi E., & Blyth W., Op. cit.

16 Aba Obrumah Crentsil "Energy Access is Fundamental to Sustainable Development, But Too Elusive" *Southern Voice*, 18 September 2023, available at <https://southernvoice.org/energy-access-is-fundamental-to-sustainable-development-but-too-elusive/#:~:text=The%20critical%20role%20of%20energy,dependable%2C%20and%20clean%20energy%20services.> [accessed 17 March 2025].

to household air pollution from burning unclean fuels in the home.¹⁷ Moreover, women and children are mostly responsible for fuel collection and housekeeping in such rural areas, and this undermines their access to quality education, professional prospects, and their quality of life. This engenders the deepening gender inequality among such a rural population.¹⁸

Further, energy plays an important role in academic excellence and enhancing digital literacy, as it is required to power computers and other IT devices that enhance learning.¹⁹ Lack of energy to power light, IT systems, etc., may therefore inhibit access to quality education, thereby threatening future earning potential, and adversely impacting the realization of goals 1, 4, and 10 of the Sustainable Development Agenda. Poor energy access may also adversely impact the promotion of inclusive industrialization, as well as foster innovation as required by Goal 9 of the Sustainable Development Agenda. Modern energy services such as natural gas and renewable energy, among others, may offer support for the creation of decent jobs, while driving economic growth in line with Goal 8 of the Sustainable Development Agenda. In addition, the sustainability of the commercial agricultural sector hinges on the deployment of mechanized and sophisticated farm equipment and technologies, which are powered by energy.²⁰ Absence of reliable and affordable energy to power such equipment and technologies may hamper food security, thereby threatening Goal 2 of the Sustainable Development Agenda.

The realization of the sustainable development agenda is therefore dependent on the availability of energy. This has informed the position that energy security is a significant criterion for the assessment of the world's progress towards the realization of the Sustainable Development Agenda.²¹ As put by another author, enhancing access to affordable energy and per capita energy consumption is a prerequisite to sustainable development.²² This is because energy consumption per capita constitutes an important determinant of a country's standard of living.²³ This indicates that energy security has implications for the various aspects of sustainable development, including economic growth and development, social well-being, and environmental protection, and sustainable development cannot be effectively realized without the provision of affordable, reliable, and sustainable energy for all.

1.2. Indicators of Energy Security

Some indicators for assessing the status of energy security in jurisdictions across the world have

17 World Health Organization "Household Air Pollution Attributable Deaths" in World Health Organization, The Global Health Observatory, available at <https://www.who.int/data/gho/data/indicators/indicator-details/GHO/household-air-pollution-attributable-deaths> [accessed 17 March 2025].

18 Aba Obrumah Crentsil, Op. cit.

19 Afeez Adiatu, Op. cit.

20 Ibid.

21 Collins Ayoo, Op. cit.

22 Afeez Adiatu, Op. cit.

23 Solomon Olayinka Oyedepo "Towards Achieving Energy for Sustainable Development in Nigeria" (2014) 34 Renewable and Sustainable Energy Reviews 255-272; Ahmad A. Abdallah & Odetokun B. Odeleke "Energy Security in Nigeria: Challenges and Prospects" (2023) 1(1) Journal of Arid Zone Economy 101-111.

been presented in the literature. First, there are energy reserves, that is, the estimated quantity of energy resources that exist with reasonable certainty and which can be accessed with available technology at an economically viable cost.²⁴ In other words, the volume of energy resources available in a country and the extent to which those resources are developed constitute a significant determinant of the state of energy security in that country. Second, is the ratio of energy production to consumption. In tandem with this is the total volume of clean energy in a country's energy mix.²⁵ This is more so as countries continue to pursue the goal of decarbonization. Third, is the energy trade balance, which refers to the difference between the volume of energy imports and exports within a country.²⁶ Countries that are net exporters of energy have a negative energy trade balance, while those that are net importers of energy have a positive energy trade balance. This implies that countries with a negative energy trade balance are more energy secure than those with a positive energy trade balance.²⁷

Fourth, there are energy prices that have implications for energy affordability for consumers. This indicates that energy security may be impeded, especially in developing and least developed countries, when energy prices rise rapidly.²⁸ The share of renewable energy in a country's energy mix is another indicator of energy security. Generally, countries that rely on a limited portfolio of non-renewable energy sources are less energy secure compared to those with access to abundant renewable energy sources.²⁹ This is a result of the inexhaustible and unlimited nature of renewable energy sources. Similar to this is the issue of energy diversity, which ensures that energy systems are resilient and adaptable to shocks in energy supplies.³⁰ Countries that rely on a limited portfolio of non-renewable energy resources are less energy secure than those with an abundant and diverse supply of energy resources.

2. Energy Security and Sustainable Development in Nigeria: A Conceptual Analysis

The rapidly increasing industrialization and urbanization in Nigeria, coupled with population growth, have implications for energy demand and energy consumption in the country.³¹ Ultimately, these pose significant challenges to energy security and the achievement of targeted sustainable development goals in the country. The energy paradox in Nigeria has long been a topic of discourse in the lit-

24 Collins Ayoo "Towards Energy Security for the Twenty-First Century" in Tolga Taner (ed) *Energy Policy* (IntechOpen 2020) 1-26, available at <https://www.intechopen.com/chapters/71825> [accessed 28 April 2025].

25 Ibid.

26 Ibid.

27 Ibid.

28 Ibid.

29 Ibid.

30 Lesbirel S. "Diversification and Energy Security Risks: The Japanese Case" (2004) 5(1) *Japanese Journal of Political Science* 1-22.

31 "Rising Population and Urbanization in Nigeria" 14 April 2022, available at <https://blog.mustardinsights.com/in-africa-r2SWJ/rising-population-and-urbanization-in-nigeria-LjvBw> [accessed 21 March 2025]; Pengfei Sheng, Yaping He & Xiaohui Guo "The Impact of Urbanization on Energy Consumption and Efficiency" (2017) 28(7) *Energy & Environment*; Pengjun Zhao & Mengzhu Zhang "The Impact of Urbanization on Energy Consumption: A 30-Year Review in China" (2018) 24 *Urban Climate* 940-953; Tithy Dev, Morteza Haghiri & Gabriela Sabau "Impacts of Urbanization on Energy Consumption in the South Asian Association for Regional Cooperation Zone" (2024) 16(18) *Sustainability* 8141.

erature. In spite of being endowed with abundant energy resources, both renewable and non-renewable, Nigeria has been unable to efficiently harness these resources to ensure energy security for its teeming population. The country is faced with significant energy poverty, with about 71% of the population unable to access reliable energy.³² According to the 2024 global sustainable development report, Nigeria's progress towards ensuring access to affordable, reliable, sustainable, and modern energy for all is plagued by major challenges.³³ Specifically, while the population with access to electricity, clean fuels, and technology for cooking, as well as the carbon emissions from fuel combustion per total electricity output, is stagnating, the renewable energy share in the total final energy consumption is decreasing.³⁴ This indicates that Nigeria is not making any tangible progress towards the realization of energy security in the country. Concerning progress made towards the realization of the Sustainable Development Agenda, the report ranked Nigeria 146 out of 166 countries, with an index score of 54.58%. Based on the report, while Nigeria is on track to realize its climate goals, progress made towards the realization of all other sustainable development goals is either stagnating, decreasing, or moderately improving.³⁵

Several empirical studies have indicated that the stagnation of energy poverty in the country has a direct adverse impact on the state of sustainable development in the country. According to a recent study, energy poverty has had adverse effects on the country's national economic development, having taken a toll on virtually all the country's economic sectors.³⁶ Specifically, lack of access to reliable energy has increased the cost of doing business in the country, with multiplier effects on the economy, including rapid inflation, non-competitiveness of its domestic products, outflow of foreign investments, and reduced domestic investments, and a very poor standard of living.³⁷ Another recent empirical study reveals that energy poverty occasions various adverse socio-economic impacts on rural populations in Nigeria.³⁸ Similarly, in a study on the impact of energy poverty on human capital development in Nigeria, it was found that energy poverty poses a significant adverse impact on the health and education outcomes of individuals in the country.³⁹ Also, it can be deduced from another study that the over-dependence on petroleum for self-generation of energy in the country occasions severe environmental

32 "Navigating a 'Just Transition' Amidst Energy Poverty in Nigeria", available at <https://www.surgeafrica.org/blog/navigating-a-just-transition-amidst-energy-poverty-in-nigeria> [accessed 21 March 2025].

33 Nigeria in "Sustainable Development Report 2024", available at <https://dashboards.sdindex.org/profiles/nigeria> [21 March 2025].

34 Ibid.

35 Ibid.

36 Scott O. Aigheyisi & Ose B. Oligbi "Energy Poverty and Economic Development in Nigeria: Empirical Analysis" (2020) 1(2) KIU Interdisciplinary Journal of Humanities and Social Sciences 183-193.

37 Ibid.

38 Ayomide S. Famewo & Vincent A. Uwala "Socio-economic Impacts of Rural Energy Poverty on Women and Students in Esa-Oke, Nigeria" (2022) 1(2) Journal of Sustainability and Environmental Management 84-93.

39 Hassan N. Wali "Impact of Energy Poverty on Human Capital: A Cross-sectional Analysis of the Rural Households in Kano State, Nigeria" (2025) 13(1) Cogent Economics & Finance 1.

degradation and a major challenge confronting sustainable development in the country.⁴⁰

As indicated by the 2024 Sustainable Development Report, the progress made towards ensuring energy security in Nigeria is plagued by major challenges. For instance, renewable energy development in Nigeria is plagued by several challenges, including high capital costs, inadequate technical expertise, a weak regulatory framework, infrastructural limitations, and ineffective grid integration, among others.⁴¹ These challenges have inhibited the large-scale deployment of renewable energy in the country. Likewise, although Nigeria is a major oil producer with an abundance of hydrocarbon reserves to power its national grid, the country still imports a substantial percentage of its required refined petroleum products. This has occasioned some challenges in the country, particularly the high cost of energy, resulting in non-affordability of energy for low-income earners, uncertainty in the availability of petroleum products, among others.⁴² In a recent report,⁴³ the Minister of Power in Nigeria raised the concern that over 60% of companies in the manufacturing sector had exited the national grid and resorted to self-generation as a result of unreliable power supply. Most of these companies self-generate energy through generators powered by diesel and petrol. The surging price of these petroleum products has a significant impact on the production costs of these companies. According to the Manufacturers Association of Nigeria (MAN), the surge in energy costs was one of the highest operating expenses for manufacturers in Nigeria in 2024, as about 40% of their total production costs were spent on generating energy.⁴⁴ Aside from the surging price of these petroleum products with the attendant impact on production costs, continued petroleum production and consumption are antithetical to the country's climate goals as well as the global sustainable development agenda. Moreover, the resultant high production cost further results in an increase in the price of manufactured products, making such products uncompetitive against imported products.

In the same report, MAN alerted that economic loss of about N10trillion is incurred annually by

40 Ndubuisi O. Purity, Anekwe R. Ifeoma & Ekwochi Eucharia "Environmental Sustainability and Sustainable Development in Nigeria: Problems and Prospects" (2020) 4(1) *International Journal of Academic Accounting, Finance & Management Research* 6-11.

41 Justin Ugwu, et al. "A Systematic Review on the Renewable Energy Development, Policies and Challenges in Nigeria with an International Perspective and Public Opinions" (2022) 11(1) *International Journal of Renewable Energy Development* 287-308; Hachimenum N. Amadi, et al. "Renewable Energy in Nigeria: Prospects and Challenges" (2024) 11(4) *European Journal of Advances in Engineering and Technology* 51-60; Chukwuma C. Okonkwo, et al. "Renewable Energy in Nigeria: Potentials and Challenges" (2021) 56(3) *Journal of Southwest Jiaotong University* 528-539; Peter Onuh, et al. "Challenges and Opportunities in Nigeria's Renewable Energy Policy and Legislation" (2024) 23(2) *World Journal of Advanced Research and Reviews* 2354-2372.

42 Agaptus Nwozor, Segun Oshewolo, & Oluwaseun Ogundele "Energy Poverty and Environmental Sustainability in Nigeria: An Exploratory Assessment" *International Conference on Energy and Sustainable Environment*, Covenant University, 18-20 June 2019.

43 Yinka Kolawole "60% Manufacturers Forced Off-grid Due to Unreliable Power Supply – Minister" *Vanguard* (NG) 4 March 2025.

44 Ibid.

Nigeria on account of inadequate power supply in the country. This amount is estimated to account for about 2% of the total GDP of the country.⁴⁵ Also, the inadequacy, unreliability, and unaffordability of energy supplies in Nigeria have led to the folding up of businesses and industries in the country, resulting in unemployment and such other adverse socio-economic impacts. This has further been aggravated by the removal of fuel subsidy by the government in 2023, leading to an increase in the price of petroleum products by more than 100%, and with attendant multifaceted socio-economic implications.⁴⁶ The generality of all these issues has significant implications for energy security and sustainable development in Nigeria.

Aside from businesses and industries, the erratic nature of energy supply in Nigeria, coupled with the instability of the national grid, has continued to encourage private energy generation through fossil-fuel-powered generators. This has become a necessity for private individuals to meet their energy demands. This is in addition to the use of combustion engines powered by petroleum in the industrial and transportation sectors of the economy.⁴⁷ Such a carbon-intensive energy supply and consumption in the country may hinder the achievement of the government's various climate goals and targets. Moreover, such high reliance on petroleum, coupled with inadequate domestic production capacity, indicates that Nigeria will continue to import petroleum products at high international market prices in order to augment its domestic production. This poses a multiplier effect on the affordability of energy by domestic consumers, thereby putting them in a precarious position regarding energy security. In fact, due to the high cost of modern energy, there has been a surge across Nigeria towards traditional energy sources, such as firewood and charcoal, for powering small-scale businesses such as fish processing and small-scale bakeries, as well as domestic uses such as cooking and heating.⁴⁸ These traditional energy sources are, however, not environmentally sustainable, as they accelerate deforestation and are harmful to human health.

Thus, the major factors affecting energy security in Nigeria include an inadequate energy supply to demand ratio, high cost of energy due to positive energy trade balance resulting in energy unaffordability for many of the population, and energy sustainability issues arising from the reliance on carbon-intensive and unsustainable energy resources. Therefore, it may be challenging to achieve energy security in the country without a significant energy mix and diversification, an energy supply boost, as

45 Ibid.

46 David D. Ogwuche, et al. "Assessing the Impact of Fuel Subsidy Removal on Economic Growth in Nigeria: A VECM Approach" (2024) 8(1) *Lapai Journal of Economics* 1-13; "Businesses Suffer as Electricity Crisis Festers" *Daily Trust* (NG) 17 March 2024; Anozie Egole "30% of Small Businesses Shut down in One Year – NASS" *Punch* (NG) 8 April 2024.

47 Afeez Adiatu "Assessing the Implications of Energy Access Deficit and Energy Poverty on Sustainable Development in Nigeria", available at <https://thecjid.org/assessing-the-implications-of-energy-access-deficit-and-energy-poverty-on-sustainable-development-in-nigeria/> [accessed 10 March 2025].

48 Ibid.

well as the adoption of eco-friendly and climate-compliant practices in energy production. The complex and multifaceted challenges associated with renewable energy development in Nigeria, coupled with the abundance of low-carbon energy resources such as natural gas, make natural gas development an imperative for enhancing energy security and sustainable development in the country.

3. Energy Security and Sustainable Development: The Role of Natural Gas

Energy security and reduction of energy's contribution to climate change have been described as two overriding challenges the energy sector faces on the path towards sustainable development.⁴⁹ Addressing these challenges requires the availability of relatively environmentally friendly energy sources with lower adverse impacts on the environment and climate. As succinctly put by an author, long-term energy security concerns border on timely investments in energy supply in line with economic developments and environmental needs.⁵⁰ Hence, the notion of energy security is posited as encompassing a balance of trade-offs between three significant energy trilemmas, which include energy availability, reliability and accessibility, energy affordability, and energy sustainability.⁵¹

Natural gas constitutes a viable energy resource for ensuring energy security when examined against the bedrock of the energy trilemma. Natural gas is identified as capable of playing a key role in the development of energy markets, especially as a result of its low-carbon emissions, as well as its availability to address the intermittent nature of renewable energy generation.⁵² Compared to other fossil fuels, natural gas is a highly versatile and efficient energy resource; it is less polluting, and its exploitation does not jeopardize normal environmental conditions, especially if paired with decarbonizing technologies or pathways, making it a viable option on the path to a low-carbon energy future.⁵³ In fact, natural gas emits about 50% less greenhouse gases than coal, and about 20% less greenhouse gases than liquid fuels. This makes it a more sustainable energy option for powering industries, homes, and fueling transportation, among others, than other fossil fuels.⁵⁴ Hence, fuel-switching from carbon-intensive fuels to natural gas has been described as one of the crucial climate actions required towards meeting

49 Fidelis O. Ogwumike & Uche M. Ozughalu "Analysis of Energy Poverty and its Implications for Sustainable Development in Nigeria" (2016) 21(3) *Environment and Development Economics* 273-290.

50 Collins Ayoo, *Op. cit.*

51 Ang B.W., Choong W.L. & Ng T.S. "Energy Security: Definitions, Dimensions and Indexes" (2015) 42 *Renewable and Sustainable Energy Reviews* 1077-1093.

52 Alberto Abanades "Natural Gas Decarbonization as Tool for Greenhouse Gases Emission Control" (2018) 6 *Frontiers in Energy Research* 1; The Atlantic Council Global Energy Centre 'The Role of Natural Gas in a Decarbonized World' (2021), available at <https://www.atlanticcouncil.org/event/role-of-natural-gas-in-a-decarbonized-world/> [accessed 24 March 2025].

53 Gas & Energy Transition Research Centre "Natural Gas to Play a Key Role in the Long Transition to a Lower Emissions Future" A Report of the Gas & Energy Transition Research Centre, University of Queensland, available at <https://gas-energy.centre.uq.edu.au/resources/education/gas-in-the-energy-transition> [accessed 17 September 2025].

54 Gas Exporting Countries Forum (GECF) "Natural Gas for Sustainable Development" (2023), available at https://www.gecf.org/_resources/files/pages/gecf-at-cop/gecf_cop28_brochure.pdf [accessed 11 March 2025].

the Sustainable Development Agenda.⁵⁵ This is because the exploitation of natural gas poses reduced carbon intensity, thereby contributing to reduced carbon emissions and improved energy efficiency. As succinctly put by the International Energy Agency (IEA), natural gas is one of the mainstays of the global energy transition, as it replaces more polluting fuels and limits emissions of carbon dioxide.⁵⁶ In addition, natural gas complements renewable energy resources by providing a reliable and accessible backup to the intermittency and unreliability of such energy sources.⁵⁷ According to a recent report from Wood Mackenzie, natural gas constitutes a crucial bridge in the energy transition by supporting the expansion of renewable energy while accelerating a shift away from more polluting fossil fuels.⁵⁸ Thus, natural gas contributes to bridging the gap between meeting global energy needs and reducing emissions from energy. In other words, natural gas plays a crucial role in striking a balance between energy security on one hand, and environmental sustainability on the other hand.

Meanwhile, affordability has been described as a key that can fully unlock the potential for development transformation subsumed in energy.⁵⁹ Aside from providing a reliable and uninterrupted source of energy supply, natural gas is considered one of the cheapest and most affordable sources of energy.⁶⁰ This is a result of low gas prices in key international markets, which promote the competitiveness of natural gas over other fossil fuels.⁶¹ Moreover, natural gas is abundantly available; as of 2021, there was an estimated volume of about 7,299 trillion cubic feet of total proven natural gas reserves globally.⁶² Natural gas is therefore considered the cleanest fossil fuel, as well as a cheaper and sustainable

55 Michael Stoppard “The Role of Gas in the Energy Transition” 13 March 2024, available at <https://www.spglobal.com/en/research-insights/special-reports/look-forward/the-role-of-gas-in-the-energy-transition> [accessed 17 September 2025].

56 International Energy Agency “The Role of Gas in Today’s Energy Transitions” World Energy Outlook Special Report, July 2019, <https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions#:~:text=Natural%20gas%20is%20one%20of,of%20today’s%20key%20energy%20markets.> [accessed 17 September 2025].

57 Gas Exporting Countries Forum (GECF) “The Role of Natural Gas in the Global Climate Agenda” (2018), available at https://www.gecf.org/_resources/files/publications/gecf_role_natural_gas_global_climate_agenda.pdf [accessed 11 March 2025].

58 Massimo D’ Odoardo, Joshua Ngu & Gavin Thompson “The Bridge: Natural Gas’s Crucial Role as a Transitional Energy Source” February 2025, available at <https://www.woodmac.com/horizons/natural-gas-transitional-energy-source/> [accessed 17 September 2025].

59 Anna Bjerde “Lighting Up Africa: Nigeria Can Show the Way” 29 February 2024, available at <https://blogs.worldbank.org/en/africacan/lighting-up-africa-nigeria-can-show-the-way> [accessed 21 March 2025].

60 Oleg E. Aksyutin, et al. “The Role of Natural Gas in Achieving Sustainable Development Goals” (2020) 10(4) International Journal of Energy Economics and Policy 463-472.

61 Alessandro Agosta, Gillian Boccara, Giorgio Bresciani, Nicholas Browne, Berend Heringa “The Impact of Decarbonization on the Gas and LNG Industry” McKinsey & Company, June 30, 2021, available at <https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-impact-of-decarbonization-on-the-gas-and-lng-industry> [accessed 24 March 2025].

62 See <https://www.eia.gov/tools/faqs/faq.php?id=52&t=8> [accessed 13 March 2025].

energy option for power generation.⁶³ This is, however, without prejudice to the benefits of gas as a viable commercial commodity in other applications; for instance, as high-value fuel for transportation and domestic use, fertilizer for agriculture, and feedstock for industries.⁶⁴

In summary, natural gas has a significant role to play in the search for energy security and sustainable development globally.

4. Natural Gas and Energy Security in Nigeria: Challenges and Prospects

The population growth in Nigeria is forecast to increase from the current 200million persons to about 400million persons by 2050. Meanwhile, due to the rapid urbanization that accompanies population growth, energy demand is predicted to outpace population growth.⁶⁵ This connotes that the projected 100% increase in population growth will be outpaced by a higher percentage in energy demand. This poses a significant implication for energy security in the country. As posited by Hisham Khatib, energy security can be ensured at a national level through the availability of abundant and various forms of indigenous energy resources; adequate national reserves to address transient interruption to or shortages of energy supply as well as unpredictably high energy demand; and adequate financial resources and technical know-how to develop indigenous renewable energy sources to meet part of domestic energy requirements.⁶⁶ In addition to these, however, it is noteworthy that in line with the sustainable development agenda, the energy needed to meet the goal of energy security in Nigeria is that which is clean, affordable, and available in abundance. Natural gas has been described as presenting such a form of energy security.

It is noteworthy that Nigeria holds the largest proven natural gas reserves in Africa, and the ninth largest in the world, with 5.94trillion cubic meters of proven natural gas reserves as at 2023.⁶⁷ This volume of natural gas is equal to about 65.34trillion kilowatt hours of energy. Of this volume, about 44billion cubic meters was produced,⁶⁸ which equals about 484billion kilowatt hour of energy. Meanwhile, the total energy demand in Nigeria during this period stood at about 40billion kilowatt hours only.⁶⁹ During the same period, the total renewable energy capacity in the country stood at 2.98 giga-

63 Philip E. Agbonifo "Opportunities, Challenges and Obstacles to Economic Growth and Sustainable Development through Natural Gas in Nigeria" (2015) 17(5) *Journal of Sustainable Development in Africa* 99-114.

64 Alessandro Agosta, et al., *Op. cit.*

65 Tony Attah "The Future of Gas, Nigerian Economy and the Global Energy Transition" *Africa Oil and Gas Report*, October 2024, available at <https://africaoilgasreport.com/2024/10/gas-commercialisation/the-future-of-gas-nigerian-economy-and-the-global-energy-transition/> [accessed 22 March 2025].

66 Hisham Khatib, *Op. cit.*

67 Doris D. Sasu "Proved Natural Gas Reserves in Nigeria 2011-2023" Statista 23 July 2024, available at <https://www.statista.com/statistics/1387331/proved-natural-gas-reserves-in-nigeria/> [accessed 24 March 2025].

68 "Volume of Natural Gas Produced in Nigeria 2013-2023" Statista 4 July 2024, available at <https://www.statista.com/statistics/1271402/production-volume-of-natural-gas-in-nigeria/> [accessed 24 March 2025].

69 Doris D. Sasu "Electricity Demand in Nigeria 2000-2023" Statista 13 August 2024, available at <https://www.statista.com/statistics/1306955/electricity-demand-in-nigeria/> [accessed 24 March 2025].

watts,⁷⁰ accounting for only about 21% of the total energy capacity in the country.⁷¹ This indicates that renewable energy is yet to attain the capacity where it can completely phase out and replace fossil fuels in Nigeria. The broader implication is that natural gas, regarded as the cleanest fossil fuel, and which is abundantly available in Nigeria, may be sustainably developed and adequately deployed to ensure energy security in the country in the short to medium term.

However, despite the abundance of natural gas resources present in Nigeria, a significant portion of these resources remains unexploited to enhance energy security in the country. This has been attributed to several challenges, including funding problems as a result of inadequate government funding of the sector, corruption, lack of technical skills, and inadequate energy investments.⁷² For instance, in almost 20 years, only an average of 2.53 trillion cubic feet of gas was produced in Nigeria, constituting less than 1% of its total national reserve. Meanwhile, of the total volume produced, associated gas accounted for 66% and non-associated gas, only 34%.⁷³

Further, there is the problem of gas shortages stemming from inadequate gas supply to power stations.⁷⁴ For instance, even though the total energy demand in 2023 was about 40 billion kilowatt hours, only about 24 billion kilowatt hours of energy were supplied in total. Specifically, in 2023, about 5.9 billion kilowatt hours were supplied in the first quarter,⁷⁵ 5.91 billion kilowatt hours in the second quarter,⁷⁶ 5.73 billion kilowatt hours in the third quarter,⁷⁷ and 6.4 billion kilowatt hours in the last quarter.⁷⁸ The implication of this is that about 16 billion kilowatt hours of energy demand remained unmet in Nigeria in 2023 alone. The question, therefore, is if about 48.4 billion kilowatt hour of energy was produced from natural gas alone, why was the total energy demand unmet, and generally, why is energy poverty prevalent in the country? The reason for this is the fact that most of the gas produced

70 Doris D. Sasu “Total Renewable Energy Capacity in Nigeria from 2011 to 2023” available at <https://www.statista.com/statistics/1278083/renewable-energy-capacity-in-nigeria/> [accessed 24 March 2025].

71 “Renewable Energy Share in Electricity Capacity in Nigeria from 2011 to 2023” available at <https://www.statista.com/statistics/1278245/renewable-energy-share-of-electricity-capacity-in-nigeria/> [accessed 24 March 2025].

72 Oluwatoyin A. Somoye “Energy Crisis and Renewable Energy Potentials in Nigeria: A Review” (2023) 188 *Renewable and Sustainable Energy Reviews* 113794.

73 PWC “Evaluating Nigeria’s Gas Value Chain”, available at <https://www.pwc.com/ng/en/assets/pdf/evaluating-nigeria-gas-value-chain.pdf> [accessed 25 March 2025].

74 Matthias Ekpu & Olusegun B. Obadina “Power Production Using Natural Gas in Nigeria: Trends, Challenges and Way Forward” (2020) 5(2) *Nigerian Research Journal of Engineering and Environmental Sciences* 873-885.

75 National Bureau of Statistics “Electricity Report Q1 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241342> [accessed 25 March 2025].

76 National Bureau of Statistics “Electricity Report Q2 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241377> [accessed 25 March 2025].

77 National Bureau of Statistics “Electricity Report Q3 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241448> [accessed 25 March 2025].

78 National Bureau of Statistics “Electricity Report Q4 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241482> [accessed 25 March 2025].

is exported, as producers prefer to sell at international market rates rather than the domestic market.⁷⁹

Moreover, even though natural gas is a relatively cleaner fossil fuel, it is not without its adverse impacts, ranging from gas flaring to fugitive methane emissions and other greenhouse gas emissions into the atmosphere in various concentrations. In fact, methane leaks from the extraction and transportation of natural gas have been indicated as exacerbating global climate change.⁸⁰

Some measures that may be harnessed to address these challenges and improve energy security in Nigeria through natural gas development are therefore highlighted. First, there is a need to ensure improved government funding to ensure adequate capital investments in gas infrastructure development in Nigeria. This may be achieved through adequate budgetary allocations to the development of the gas sector in the country. Second, corruption in the gas sector may be addressed through improved transparency and disclosure requirements in the administration of funding and procurement of gas investments, such as disclosure of the beneficial owners and politically-exposed persons involved in gas contracts. Third, the lack of technical skills may be addressed through the implementation of local content policies in the gas sector.

The problem of gas shortages may be addressed through the requirements of host-granting instruments. For instance, lessees and licensees may be required to develop a particular ratio of gas fields to oil fields, and to retrofit carbon technologies into their facilities to ensure that associated gas from their oil production is captured rather than vented or flared. This will ensure that the volume of gas in the mix of energy produced per time is increased to meet the increasing energy demand. In addition, there is a need for a market-driven pricing system in the Nigerian gas sector based on international market prices rather than a domestically regulated price. This will ensure that gas producers do not prioritize gas exports over an adequate supply of gas to the domestic market, hence, enhancing the adequate supply of gas to power stations.

Furthermore, inadequate energy investments may be addressed through regulatory and policy measures that encourage private sector investment in the gas sector. Such measures may include incentivizing investments in natural gas through economic instruments, and disincentivizing petroleum production and consumption, such as through contractual stipulations in petroleum contracts, and carbon pricing mechanisms. This will promote divestment from other fossil fuel sources and increase private sector investment in natural gas development instead. These measures will not only improve investments in the gas sector, but they will also boost the share of natural gas in the total national energy mix.

To ensure energy security, countries, especially developing countries, should regard it as a policy priority. The adoption of policies and regulatory instruments that support the provision of energy services in cleaner and more efficient ways is a precondition for the realization of the Sustainable Development

⁷⁹ Matthias Ekpu & Olusegun B. Obadina, *Op. cit.*

⁸⁰ World Bank Decarbonizing Natural Gas through Carbon Capture, Utilization and Storage (CCUS) (International Bank for Reconstruction and Development/The World Bank, 2023) 59; Centre for Climate and Energy Solutions “Natural Gas”, available at <https://www.c2es.org/content/natural-gas/> [accessed 25 March 2025].

opment Agenda. This calls for legal and regulatory support for technological innovations that mitigate the adverse impacts of natural gas development. In line with circular economy principles, methane and other greenhouse gases associated with natural gas production may be captured and further utilized as feedstock in various industrial applications. This requires regulatory and policy support for investments in CCUS and other carbon technologies. Similarly, policy and regulatory frameworks may be adopted to foster energy efficiency through carbon credits and such emission trading systems. There may also be the need to enforce ESG management through an integrated reporting system, which enhances the sustainability of natural gas development.

Moreover, energy prices have implications for energy affordability. Energy prices are generally determined by market conditions such as the ratio of energy supply to demand, as well as market policies and regulations, such as taxes and sustainable subsidies, etc., put in place by governments to achieve particular market outcomes. Market and institutional reforms that improve gas affordability for consumers through a responsible gas subsidy regime are recommended. Such a subsidy regime may lead to consumers' behavioral changes and energy preferences, thus reducing over-dependence on petroleum as an energy source.

Furthermore, to ensure energy security, there is a need for synergy between different industries to enhance the expansion of the natural gas markets and widen the scope of natural gas usage, such as in transportation, power, domestic use, agricultural use, and feedstock for industries. For instance, the automobile sector can be supported to explore available technologies for the manufacturing of automobiles and other combustion engines that utilize gas instead of petroleum and diesel. To enhance energy efficiency, there is a need to raise public awareness on the adverse environmental impacts of energy consumption through public orientation and educational initiatives. This can encourage responsible consumption of energy and energy-related products.

In conclusion, the upscale of the development of the natural gas sector in Nigeria has the potential to enhance energy security and sustainable development in the country. Aside from this, it will enhance the country's LNG export opportunities while also expanding the opportunities for domestic gas utilization across different sectors, including transportation, domestic, and industrial use, among others. According to a report, the development and domestic utilization of Nigeria's proven gas reserves is expected to stimulate the economy and potentially generate a Gross Value Added of US\$18.3 billion to the domestic economy annually. In addition, it is expected to support 6.5 million full-time equivalent jobs annually.⁸¹

Conclusion

The primary objective of this study is the examination of the role of natural gas in enhancing energy security and sustainable development in Nigeria. This objective is premised on the persistent energy poverty in the country, having found that about 71% of the nation's population is unable to access

81 PWC "Evaluating Nigeria's Gas Value Chain" Op. cit.

reliable energy. This state of energy poverty poses a multiplier effect on the realization of basic sustainable development goals in Nigeria. As found by this study, aside from her climate goals, Nigeria is not making any significant progress towards the realization of all other sustainable development goals. This is because the realization of the global sustainable development agenda depends to a large extent on the availability of energy; for instance, energy influences economic growth and several aspects of social well-being.

It is, however, noted that energy is not without its downside, as energy consumption is noted to contribute dominantly to the global atmospheric greenhouse gas concentrations, thereby worsening global climate change. On this premise, this study submits that energy security and energy sustainability represent two overriding challenges that must be addressed on the path towards sustainable development. To address these challenges, there is a need for a shift from environmentally polluting and degrading energy resources to readily available and sustainable energy resources.

Within the Nigerian context, this study finds that a shift from crude oil to natural gas presents a viable solution to addressing the country's energy security challenges. This is due to the versatility and efficiency of natural gas as an energy resource, as well as its abundant availability in the country. Although natural gas is also plagued by some challenges, it is nevertheless posited that natural gas presents more potential to address the energy security issues in Nigeria in the short to medium term. To satisfy the level of energy demand growth as forecast, it is unlikely to completely phase out fossil fuels, as it is expected that fossil fuels will continue to play a significant role in the total national energy mix. Natural gas, regarded as the cleanest fossil fuel, in comparison to crude oil and coal, has a dominant role to play in this regard. This is in line with the energy trilemma, which focuses on the availability of energy resources in abundance to meet growing energy demands, affordability of such energy resources, and ensuring that such energy resources do not jeopardize the environment. As already established, within the context of energy security in Nigeria, natural gas has a critical role to play in ensuring a balance of the energy trilemma.

Therefore, there is a need for a deliberate focus by relevant stakeholders, such as government, industry, consumers, and civil society actors, among others, on natural gas development as a path to ensuring energy security and sustainable development in Nigeria. On the part of the government, this calls for significant legal and policy reforms that promote the commercialization of natural gas in Nigeria. Such reforms may include regulatory provisions and incentives that support both financial and infrastructural investments in the gas sector, ranging from provisions on capital grants to tax incentives, and long-term green bonds, among others. These reforms encourage private investment in the gas sector, thereby promoting significant development of the sector. Civil society actors, whose primary objectives usually include the promotion of social goals, may leverage their political and social influence to promote the development of the gas sector in Nigeria. Such groups may engage in lobbying

and dialogues with the government, as well as partnerships with the energy industry, with regard to the development of natural gas in Nigeria.

Energy consumers, through their marketplace decisions, also have a role to play in the development of the natural gas sector in Nigeria. This calls for an embrace of the principle of responsible consumption by energy consumers in Nigeria. This connotes that energy consumers must be willing to minimize the environmental footprint of their energy consumption by consuming less polluting natural gas rather than more polluting oil. To support such responsible energy consumption, however, the government must ensure the availability and affordability of gas supply in the domestic gas market. The government may achieve this by adopting sustainable fuel subsidy reforms, whereby a gas subsidy regime is implemented to enhance the affordability of gas in the domestic gas market. Such a subsidy regime provides a boost for domestic gas commercialization, as energy consumers are encouraged to patronize natural gas over more polluting oil. To further support responsible energy consumption, energy consumers must be aware of the risks posed by the current pattern of energy consumption on one hand, and the viability of a cleaner energy option, such as natural gas, on the other hand. Such public advocacy and awareness on natural gas may be taken up by civil society actors as part of their social objectives.

In conclusion, a nexus of these different approaches will contribute immensely to the development of the natural gas sector while improving gas supply, consumption, and ultimately energy security and sustainable development in Nigeria.

References

I. Books:

- Ayoo Collins “Towards Energy Security for the Twenty-First Century” in Tolga Taner (ed) *Energy Policy* (Intech Open, 2020).
- Goldemberg Jose “Rural Energy in Developing Countries” in *World Energy Assessment: Energy and the Challenge of Sustainability* (UNDP, 2000).
- Khatib Hisham “Energy Security” in *World Energy Assessment: Energy and the Challenge of Sustainability* (UNDP, 2000).
- World Bank *Decarbonizing Natural Gas through Carbon Capture, Utilization and Storage (CCUS)* (International Bank for Reconstruction and Development/The World Bank, 2023)

II. Articles:

- Abanades Alberto “Natural Gas Decarbonization as Tool for Greenhouse Gases Emission Control” (2018) 6 *Frontiers in Energy Research* 1.
- Abdallah Ahmad A. & Odetokun B. Odeleke “Energy Security in Nigeria: Challenges and Prospects” (2023) 1(1) *Journal of Arid Zone Economy* 101-111.
- Agbonifo Philip E. “Opportunities, Challenges and Obstacles to Economic Growth and Sustainable Development through Natural Gas in Nigeria” (2015) 17(5) *Journal of Sustainable Development in Africa* 99-114.
- Aigheyisi Scott O. & Ose B. Oligbi “Energy Poverty and Economic Development in Nigeria: Empirical Analysis” (2020) 1(2) *KIU Interdisciplinary Journal of Humanities and Social Sciences* 183-193.
- Aksyutin Oleg E., et al. “The Role of Natural Gas in Achieving Sustainable Development Goals” (2020) 10(4) *International Journal of Energy Economics and Policy* 463-472.
- Ang B.W., Choong W.L. & Ng T.S. “Energy Security: Definitions, Dimensions and Indexes” (2015) 42 *Renewable and Sustainable Energy Reviews* 1077-1093.
- Dev Tithy, Morteza Haghiri & Gabriela Sabau “Impacts of Urbanization on Energy Consumption in the South Asian Association for Regional Cooperation Zone” (2024) 16(18) *Sustainability* 8141.
- Ekpu Matthias & Olusegun B. Obadina “Power Production Using Natural Gas in Nigeria: Trends, Challenges and Way Forward” (2020) 5(2) *Nigerian Research Journal of Engineering and Environmental Sciences* 873-885.
- Famewo Ayomide S. & Vincent A. Uwala “Socio-economic Impacts of Rural Energy Poverty on Women and Students in Esa-Oke, Nigeria” (2022) 1(2) *Journal of Sustainability and Environmental Management* 84-93.

- Gitelman Lazar, Elena Magaril, & Mikhail Kozhevnikov “Energy Security: New Threats and Solutions” (2023) 16(6) *Energies* 2869.
- Hachimenum N. Amadi, et al. “Renewable Energy in Nigeria: Prospects and Challenges” (2024) 11(4) *European Journal of Advances in Engineering and Technology* 51-60.
- Okonkwo Chukwuma C., et al. “Renewable Energy in Nigeria: Potentials and Challenges” (2021) 56(3) *Journal of Southwest Jiaotong University* 528-539.
- Lesbirel S. “Diversification and Energy Security Risks: The Japanese Case” (2004) 5(1) *Japanese Journal of Political Science* 1-22.
- Mulugetta Jacob, Essel Ben Hagan & Daniel Kammen “Energy Access for Sustainable Development” (2019) 14 *Environmental Research Letters* 1.
- Ndubuisi O. Purity, Anekwe R. Ifeoma & Ekwochi Eucharia “Environmental Sustainability and Sustainable Development in Nigeria: Problems and Prospects” (2020) 4(1) *International Journal of Academic Accounting, Finance & Management Research* 6-11.
- Ofosu-Peasah G., Ofosu Antwi & Blyth W. “Factors Characterizing Energy Security in West Africa: An Integrated Review of the Literature” (2021) 148 *Renewable and Sustainable Energy Reviews* 111259.
- Ogwuche David D., et al. “Assessing the Impact of Fuel Subsidy Removal on Economic Growth in Nigeria: A VECM Approach” (2024) 8(1) *Lapai Journal of Economics* 1-13.
- Ogwumike Fidelis O. & Uche M. Ozughalu “Analysis of Energy Poverty and its Implications for Sustainable Development in Nigeria” (2016) 21(3) *Environment and Development Economics* 273-290.
- Onuh Peter, et al. “Challenges and Opportunities in Nigeria’s Renewable Energy Policy and Legislation” (2024) 23(2) *World Journal of Advanced Research and Reviews* 2354-2372.
- Oyedepo Solomon Olayinka “Towards Achieving Energy for Sustainable Development in Nigeria” (2014) 34 *Renewable and Sustainable Energy Reviews* 255-272.
- Sheng Pengfei, Yaping He & Xiaohui Guo “The Impact of Urbanization on Energy Consumption and Efficiency” (2017) 28(7) *Energy & Environment*.
- Somoye Oluwatoyin A. “Energy Crisis and Renewable Energy Potentials in Nigeria: A Review” (2023) 188 *Renewable and Sustainable Energy Reviews* 113794.
- Sovacool Benjamin K. & Ishani Mukherjee “Conceptualizing and Measuring Energy Security: A Synthesized Approach” (2011) 36(8) *Energy* 5343-5355.
- Thai-Ha Le & Canh Phuc Nguyen “Is Energy Security a Driver for Economic Growth? Evidence from a Global Sample” (2019) 129 *Energy Policy* 436-451.

- Ugwu Justin, et al. “A Systematic Review on the Renewable Energy Development, Policies and Challenges in Nigeria with an International Perspective and Public Opinions” (2022) 11(1) International Journal of Renewable Energy Development 287-308.
- Wali Hassan N. “Impact of Energy Poverty on Human Capital: A Cross-sectional Analysis of the Rural Households in Kano State, Nigeria” (2025) 13(1) Cogent Economics & Finance 1.
- Warr BS & Ayre RU “Evidence of Causality between the Quantity and Quality of Energy Consumption and Economic Growth” (2010) 35(4) Energy 1688-1693
- Zhao Pengjun & Mengzhu Zhang “The Impact of Urbanization on Energy Consumption: A 30-Year Review in China” (2018) 24 Urban Climate 940-953.

III. Websites:

- “A Quest for Energy Security in the 21st Century: Resources and Constraints” A Report of Asia Pacific Energy Research Centre (2007), available at https://aperc.or.jp/file/2010/9/26/APERC_2007_A_Quest_for_Energy_Security.pdf
- “Navigating a ‘Just Transition’ Amidst Energy Poverty in Nigeria”, available at <https://www.surgeafrica.org/blog/navigating-a-just-transition-amidst-energy-poverty-in-nigeria>
- “Renewable Energy Share in Electricity Capacity in Nigeria from 2011 to 2023” available at <https://www.statista.com/statistics/1278245/renewable-energy-share-of-electricity-capacity-in-nigeria/>
- “Rising Population and Urbanization in Nigeria” 14 April 2022, available at <https://blog.mustardinsights.com/in-africa-r2SWJ/rising-population-and-urbanization-in-nigeria-LjvBw>
- “Volume of Natural Gas Produced in Nigeria 2013-2023” Statista 4 July 2024, available at <https://www.statista.com/statistics/1271402/production-volume-of-natural-gas-in-nigeria/>
- Adiatu Afeez “Assessing the Implications of Energy Access Deficit and Energy Poverty on Sustainable Development in Nigeria”, available at <https://thecjid.org/assessing-the-implications-of-energy-access-deficit-and-energy-poverty-on-sustainable-development-in-nigeria/>
- Centre for Climate and Energy Solutions “Natural Gas”, available at <https://www.c2es.org/content/natural-gas/>
- Egole Anozie “30% of Small Businesses Shut down in One Year – NASSI” Punch (NG) 8 April 2024, available at <https://punchng.com/30-of-small-businesses-shut-down-in-one-year-nassi/>
- Gas Exporting Countries Forum (GECF) “Natural Gas for Sustainable Development” (2023), available at https://www.gecf.org/_resources/files/pages/gecf-at-cop/gecf_cop28_brochure.pdf
- Gas Exporting Countries Forum (GECF) “The Role of Natural Gas in the Global Climate Agenda” (2018), available at https://www.gecf.org/_resources/files/publications/gecf_role_natural_gas_global_climate_agenda.pdf

- International Energy Agency “World Energy Outlook 2022” available at <https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf>
- Kolawole Yinka “60% Manufacturers Forced Off-grid Due to Unreliable Power Supply – Minister” Vanguard (NG) 4 March 2025, available at <https://www.vanguardngr.com/2025/03/60-manufacturers-forced-off-grid-due-to-unreliable-power-supply-minister/>
- Kowalski George & Sead Vilgorac “Energy Security Risks and Risk Mitigation: An Overview”, available at https://unece.org/fileadmin/DAM/oes/nutshell/2008/9_Energy_Security_Risks.pdf
- National Bureau of Statistics “Electricity Report Q1 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241342>
- National Bureau of Statistics “Electricity Report Q2 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241377>
- National Bureau of Statistics “Electricity Report Q3 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241448>
- National Bureau of Statistics “Electricity Report Q4 2023”, available at <https://www.nigerianstat.gov.ng/elibrary/read/1241482>
- Nigeria in “Sustainable Development Report 2024”, available at <https://dashboards.sdindex.org/profiles/nigeria>
- <https://www.surgeafrica.org/blog/navigating-a-just-transition-amidst-energy-poverty-in-nigeria>
- Nwozor Agaptus, Segun Oshewolo, & Oluwaseun Ogundele “Energy Poverty and Environmental Sustainability in Nigeria: An Exploratory Assessment” International Conference on Energy and Sustainable Environment, Covenant University, 18-20 June 2019., available at <https://iopscience.iop.org/article/10.1088/1755-1315/331/1/012033>
- World Energy Council “World Energy Trilemma 2024: Evolving with Resilience and Justice” (2024), available at <https://www.worldenergy.org/publications/entry/world-energy-trilemma-report-2024>
- World Health Organization “Household Air Pollution Attributable Deaths” in World Health Organization, The Global Health Observatory, available at <https://www.who.int/data/gho/data/indicators/indicator-details/GHO/household-air-pollution-attributable-deaths>
- Agosta Alessandro, Gillian Boccara, Giorgio Bresciani, Nicholas Browne, Berend Heringa “The Impact of Decarbonization on the Gas and LNG Industry” McKinsey & Company, June 30, 2021, available at <https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-impact-of-decarbonization-on-the-gas-and-lng-industry>
- Attah Tony “The Future of Gas, Nigerian Economy and the Global Energy Transition” Africa Oil and Gas Report, October 2024, available at <https://africaoilgasreport.com/2024/10/gas-commercialisation/the-future-of-gas-nigerian-economy-and-the-global-energy-transition/>

- Bjerde Anna “Lighting Up Africa: Nigeria Can Show the Way” 29 February 2024, available at <https://blogs.worldbank.org/en/africacan/lighting-up-africa-nigeria-can-show-the-way>
- Crentsil Aba Obrumah “Energy Access is Fundamental to Sustainable Development, But Too Elusive” Southern Voice, 18 September 2023, available at <https://southernvoice.org/energy-access-is-fundamental-to-sustainable-development-but-too-elusive/#:~:text=The%20critical%20role%20of%20energy,dependable%2C%20and%20clean%20energy%20services>
- The Atlantic Council Global Energy Centre ‘The Role of Natural Gas in a Decarbonized World’ (2021), available at <https://www.atlanticcouncil.org/event/role-of-natural-gas-in-a-decarbonized-world/>
- PWC “Evaluating Nigeria’s Gas Value Chain”, available at <https://www.pwc.com/ng/en/assets/pdf/evaluating-nigeria-gas-value-chain.pdf>
- Sasu Doris D. “Electricity Demand in Nigeria 2000-2023” Statista 13 August 2024, available at <https://www.statista.com/statistics/1306955/electricity-demand-in-nigeria/>
- Sasu Doris D. “Proved Natural Gas Reserves in Nigeria 2011-2023” Statista 23 July 2024, available at <https://www.statista.com/statistics/1387331/proved-natural-gas-reserves-in-nigeria/>
- Sasu Doris D. “Total Renewable Energy Capacity in Nigeria from 2011 to 2023” available at <https://www.statista.com/statistics/1278083/renewable-energy-capacity-in-nigeria/>
- “Businesses Suffer as Electricity Crisis Festers” Daily Trust (NG) 17 March 2024, available at <https://dailytrust.com/businesses-suffer-as-electricity-crisis-festers/>